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Fabrications and superconducting properties of Ba1-xKxFe2As2 composite round wires

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Iron-based superconductors (IBS) are promising candidates for high-field applications not only because of their advanced superconducting properties but also due to the cost-effective powder-in-tube method. While IBS tapes have achieved high critical current density (J_c) above J_c(4.2 K, 10 T)=2×10^5 A/cm^2, improving the J_c of round wires has been challenging. Here, we fabricated the $Ba_{1-x}K_xFe_2As_2$ single- and multi-filamentary composite round wires by the hot-isostatic-pressing (HIP) method and the high-strength sheath aided deformation method. The high pressure (˜200 MPa) at high temperatures (˜750 ^{o}C) induced isotropic contraction of the wires and achieved a nearly 100 % dense superconducting core in the HIP Cu/Ag wires. Comparatively, the Vickers hardness of the stainless steel (SS) sheath strengthened round wires proved competitive even without high-pressure sintering. Finite element simulation indicated that groove rolling applied a large deformation stress, overcoming the high yield strength of SS, and densified the grains in the filaments. Electron backscatter diffraction (EBSD) and microstructure analysis revealed that drawing and groove rolling induced fiber texture and concentric texture, respectively. Finally, material cost and thermal stability are discussed based on the new conductor architecture. These findings underscore the importance of conductor design and deformation processes for achieving low-cost, high-performance iron-based superconducting wires and tapes.

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